METHOD AND DEVICE FOR THE IMPROVEMENT OF THE PROPERTIES OF A FIBER MATERIAL WEB PRODUCED IN A SHEET FORMING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the invention.

The present invention relates to a method and device for improving the characteristics of a fiber material web, particularly a paper, cardboard or tissue web produced from a fibrous suspension, in a sheet forming device.

2. Description of the related art.

The properties (quality) of a fiber material web produced from a fibrous suspension are substantially determined by relative motion between the fibrous suspension and the at least one wire of the sheet forming device. The formation and the bursting pressure are thereby improved to an optimum with the increasing differential between the jet speed and the wire speed ($|\Delta v| = |v_{jet} - v_{wire}|$). Other properties, for example $SCT_{transverse}$ (Short Span Compression Test) which is an important parameter for liner and test liner, are at their maximum at approximately $|\Delta v| =$ 0 m/min. This applies independently of the former concept. In addition, the properties of a fiber material web that was produced from a fibrous suspension are also determined by the wire tension. The general rule applies that a reduction in the wire tension will result in increased turbulence at the Foudrinier wire, in the dewatering zone and/or in the forming zone.

Shaking devices are used in some instances in paper machines for graphic papers, in order to improve the formation through the additionally produced shear stress. A shaking device of this type, also referred to as a shaker in the field, is known for example from the German prior art document by the applicant, DE 197 04 740 A1 (PB10484 DE). The disclosed shaking apparatus that causes a reciprocating motion of a body along an axis of said body, especially of a roll in a paper machine, including a first eccentric drive that is connected with the body in the

direction of the body's axis, with a first motor and a first shaking frequency; and also including a second eccentric drive that is connected with the body in the direction of the body's axis, with a second motor and a second shaking frequency. The eccentric position of the two eccentric drives is adjustable relative to each other, in order to adjust the stroke of the reciprocating motion of the body. In addition, the shaking apparatus is equipped with a controller by way of which the relative position of the second motor is adjustable through a cascade action control that is dependent upon the relative position of the first motor.

One disadvantage of the already familiar shaking apparatus is the formation changes periodically with the dual shaking frequency. For example: at a shaking frequency of f = 300 1/min and a wire speed of v = 900 m/min the wire moves at between maximum and minimum transverse acceleration of 0.75 m.

DE 297 14 908 U1 describes a forming shoe with perforations whose length viewed transversely to the direction of machine travel is only half that of the wire width at most. The perforations that may, for example be slot-like, slant with at least one of their main axis toward the direction of wire travel. The perforations may be offset toward each other, transversely to the direction of wire travel. The forming shoe may be equipped with a curved surface and suction.

SUMMARY OF THE INVENTION

The present invention provides a method and an apparatus for improving the properties of a fiber web, particularly a paper, cardboard or tissue web produced from a fibrous material suspension in a sheet forming device, whereby the properties that require a stronger fiber orientation transversely to the direction of wire travel are improved without essentially detrimentally affecting those properties that profit from a stronger relative motion between the fibrous suspension and the at least one wire of the sheet formation device.

The present invention provides a fiber material web that is formed from the fibrous suspension carried by at least one wire over a multitude of wire guiding and dewatering elements, viewed in direction of wire travel. In accordance with this first aspect, the present invention further relates to a device for the implementation of the method in accordance with the invention. Within the scope of this description, the designation "fiber material" is used to describe fiber material derived from chemical pulp, wood pulp, recovered paper, and from a mixture of synthetic fibers. According to a second, more general aspect, the current invention relates to a method, as well as to a device for the production of a fiber web from a fibrous suspension, particularly a paper, cardboard or tissue web.

The first-mentioned properties (transverse strengths) include for example $SCT_{transverse}$, Tear $length_{transverse}$ and flexural $strength_{transverse}$ whereas the formation, for example, would come under the category of the second-mentioned properties. Within the scope of this description, the term "properties" is used for the fiber material web in its entirety, as well as for at least a section of said web.

The present invention provides a method whereby cross flows are created in the fiber suspension relative to the direction of wire travel, in order to achieve better web properties and higher transverse strength. These cross flows subject the fibrous suspension to additional shear stresses that tear open existing fiber flakes and cause a stronger fiber orientation transversely to the direction of wire travel, resulting in improved web properties and higher transverse strengths. The transverse flows are produced preferably by at least one wire guiding or dewatering element that is structured and/or directed transversely to the direction of wire travel, since this element initiates hydrodynamic impulses in the fibrous suspension that are effective transversely to the direction of wire travel and that cause the aforementioned stronger fiber orientation.

The present invention provides at least one wire guiding or dewatering element is structured and/or directed transversely to the direction of wire travel in order to produce cross flows relative to the direction of wire travel, with the purpose to producing better web properties and higher transverse strengths. The structuring in the wire guiding or dewatering element is preferably in the form of indentations and/or elevations, whereby the elevations are in the embodiment of nubs and/or crowned and/or dome shaped and/or oblong structures. These formations represent an effective medium for the production of cross flows in the fibrous suspension relative to the direction of wire travel. In addition they can be manufactured and operated cost effectively.

The wire guiding or dewatering element in a preferred embodiment can be in the form of a plate, especially a support plate, in the form of a strip, especially a support strip, in the form of inclined short foils that are preferably curved, or short strips that are preferably straight, or in the form of a rotating element, such as a grooved or spirally grooved roll, since any of these types can be installed into a sheet forming apparatus without problems. In addition, the rotating element and the wire can rotate or move at the same speed, or at different speeds (synchronism, forward motion, after-running) in the same, or in opposite direction. Naturally, the rotating element can also rotate at crawling speed, possibly even with an installed cleaning device.

With regard to the arrangement of the structured and/or directed wire guiding or dewatering element it is advantageous if, viewed in direction of wire travel, it is positioned as not to be laterally offset, or positioned to be laterally offset and staggered or laterally offset and alternating. In principle these layouts can be easily accomplished and are easily adaptable to various application instances.

With regard to the creation of cross flows relative to the direction of wire travel it is also advantageous when the structured and/or directed wire guiding or dewatering element is

positioned alternating or in a pattern with a non-structured and/or non-directed wire guiding or dewatering element. This arrangement permits the creation of smaller and/or controllable cross flows relative to the direction of wire travel, resulting in better web properties and higher transverse strengths without having to incur higher investment and operating costs. In order to noticeably increase the cross flows in the fibrous suspension relative to the direction of wire travel the structured and/or directed wire guiding or dewatering element is supported flexibly and/or rigidly, whereby in the second instance its position is adjustable relative to the wire, for example through sliding or pivoting. To achieve continued intensification of the cross flows relative to the direction of wire travel the structured and/or directed wire guiding or dewatering element is supplied with vacuum. The vacuum supply is provided cost-effectively preferably by means of at least one controlled vacuum box.

The structured and/or directed wire guiding or dewatering element can, in an additional advantageous design of the present invention, also be in the embodiment of a spreader roll, a spreader type suction unit with a herringbone pattern, or a curved spreader bar, since these types of units can also be installed into a sheet forming device without any problems and to be fully operative. The structured and/or directed wire guiding or dewatering element can be installed in a hybrid former type sheet forming apparatus, whereby at least one element is installed only on the Foudrinier side or only on the hybrid former side, or on both sides. It can however, also be installed in a gap former type sheet forming apparatus, whereby at least one element would be installed on only one side of the wire, or on both sides of the wire.

In accordance with the second more general aspect the present invention provides an improved method, as well as an improved apparatus for the production of a fiber material web, specifically a paper, cardboard or tissue web whereby, in order to achieve certain properties in the end product, the main fiber direction can be influenced accordingly. The present invention

provides for the production of a fiber material web from a fibrous suspension, especially a paper, cardboard or tissue web whereby during dewatering in the forming zone at least zonal pressure gradients are produced in the fibrous suspension, in order to influence the main fiber direction in the fiber material web accordingly. Based on this arrangement it is, for example, possible to obtain a dynamic pressure at the impact edge. This can imply accepting an increased wire wear and tear.

According to a preferred arrangement of the present invention, the fibrous suspension is treated with vacuum in the forming zone during dewatering. The pressure gradient generation and/or vacuum treatment occur advantageously, in sections, transversely to the machine direction. Therefore, a cross directionally sectioned vacuum chamber can be utilized. The pressure gradient generation and/or vacuum treatment occur preferably controlled and/or regulated.

Again, one or several dewatering, forming and/or wire guiding elements can be utilized for the generation of the pressure gradients. In principle, especially the elements described previously in connection with the first aspect of the current invention can again be utilized. The fiber material web that is formed from the fibrous suspension can also be carried over the dewatering, forming and/or wire guiding elements by way of at least one wire. Particularly foil strips that are positioned diagonally to the direction of web travel can be utilized as dewatering, forming and/or wire guiding elements.

For dewatering, forming and/or wire guidance at least one dewatering box can especially be used that has at least one plate cover that is equipped with diagonal slots relative to the direction of web travel and that provides a foil effect. The diagonally progressing bars in the plate cover can be beveled on the discharge side. As an option, the dewatering box can be supplied with vacuum. In accordance with a practical embodiment of the method of the present

invention, a controlled and/or regulated dewatering box that is supplied with vacuum is preferably used. Advantageously, at least one dewatering box, for example of the type described in connection with the first aspect of the present invention, is used in combination with at least one graduated foil.

It is also advantageous if at least one dewatering box, for example of the type described in connection with the first aspect of the present invention, is used in combination with so-called Varioline strips (especially IBS Varioline-system). A suitable Varioline-box can, for example include two different strips, one dewatering strip that can for example include ceramic, and an adjustable strip that can for example include polyethylene. These two strips can be of different heights, whereby the height differential depends upon the production conditions. The strips can alternate across the box. A low vacuum pulls the moving wire downward, in direction of the Varioline strip. A wave motion is caused. This motion, as well as the pressure of the water film between the wire and the Varioline strip causes a controlled activity in the fibrous suspension. The rate of dewatering can be controlled through the level of applied vacuum, as well as through the height differential between the strips. An additional opportunity of controlling the dewatering exists in a variation of the open area of the box that is achieved by changing the widths of the strips.

An additional advantage is, if at least one dewatering, forming and/or wire guiding element possesses a curved surface over which the fibrous suspension is carried by way of at least one wire. The curvature radius of the surface may, for example be larger than 2 m, especially larger than 5 m and preferably larger than 10 m. The angle of wrap is preferably in a range of approximately 10° to approximately 30°. When viewed cross directionally the dewatering, forming and/or wire guiding elements are preferably arranged in sections and/or are sectionally adjustable.

All paper and cardboard related parameters, for example, the structural characteristics like porosity, fiber orientation, formation and strength vary across the machine width. The reason for this is, for example, inconsistencies in the sheet formation and sheet drying resulting especially in uneven shrinkage across the web width. The cross profiles are in part so poor that the rolls from the edge fetch lower prices, or in extreme instances are allocated to waste.

According to a third aspect of the present invention cites a method, as well as an apparatus with which the cross profiles of essential product properties, that is especially paper and/or cardboard properties can be improved. To this end and in order to improve the cross profiles, a sectional control and/or regulation of the sheet formation should be possible through sheet forming elements that are arranged in sections in cross machine direction and that permit important paper and/or cardboard properties, such as the formation and especially the L/Q (longitudinal/cross) ratios such as the TSI (tensile-stiffness-index), the Tear length, SCT, etc. to be influenced. A preferred inventive embodiment is characterized in that the adjustment parameters of the dewatering, forming and/or wire guiding elements that are, when viewed cross directionally, arranged in sections and/or are sectionally adjustable are adjusted correspondingly in order to influence a respective property profile of the fiber material web. Profile related problems can therefore be countered effectively, by making appropriate variations to the adjustment parameters across the width.

In accordance with a functional, practical embodiment of the present invention respective changes in the adjustment parameters of the dewatering, forming and/or wire guiding elements that are, when viewed cross directionally, arranged in sections and/or are sectionally adjustable can occur on the basis of off-line measurements, especially steady state. Moreover, a respective change of the adjustment parameters of the dewatering, forming and/or wire guiding elements

that are, when viewed cross directionally, arranged in sections and/or are sectionally adjustable can occur especially manually, via a control system or via at least a closed control loop.

In accordance with a preferred functional embodiment at least one closed control loop is utilized that encompasses an in-line acquisition of the product characteristic that is to be influenced, or a characteristic correlating with the product characteristic, a control algorithm and the relating final control element, such as especially the relating dewatering, forming and/or wire guiding element. The product property that is to be influenced can, for example be the TSI, the fiber orientation, the flow velocity distribution, forming, etc.

As already mentioned, instead of the product characteristic that is to be influenced, a characteristic that correlates well with the target characteristic can especially be acquired and be included in the adjustment. The following examples are cited: Most of the strengths such as tear strength, SCT and bursting pressure cannot be captured in-line since this would be associated with destructive test procedures. On the basis of, for example the fiber orientation, the respective target strength can be calculated based on correlations and can, if necessary, be corrected through an adjustment. If necessary, the adjustment can consider several in-line measured variables, i.e. the oven dried FbM profile.

In certain instances it is also advantageous if at least one control algorithm is incorporated into the closed control loop, for mapping, especially with an appropriate interface control. As already mentioned, any of the previously discussed dewatering, forming and/or wire guiding elements can be utilized as a respective final control element. Moreover, the angle of attack of the dewatering, forming and/or wire guiding elements can be adjustable relative to the direction of web travel, in fact especially in the plane tentered by the machine direction and machine cross direction. An intervention is therefore possible, for example, through adjustment of the angle of attack.

An additional potentiality exists in the utilization of a dewatering box that is equipped with several vacuum zones and/or elements that are arranged successively in transverse direction, and through which especially the longitudinal/cross relationships can be influenced. For example a dewatering box including a cover or plate that is diagonally slotted relative to the direction of web travel can be utilized. In addition the utilization of a dewatering box that is equipped with foil strips that are arranged diagonally to the direction of web travel is also feasible.

The vacuum in the individual vacuum zones is preferably individually controllable. Therefore, an intervention is also possible for example by adjusting the vacuum in the individual zones. Typical values for the vacuum are, for example, in a range of 0 to approximately 50 kPa, preferably in a range of 0 to approximately 25 kPa. However, values exceeding 50 kPA are also possible. As a rule they determine smaller slot widths and/or lower wire tensions. They have however hitherto not been used due to high vacuum costs and "sheet sealing".

In accordance with a modified embodiment of the method according to the present invention, the dewatering, forming and/or wire guiding elements or the dewatering box can be equipped with at least one slot having a changeable slot width. In addition to the adjustable slot width a vacuum supply that is sectioned in cross direction can also be provided. In certain instances it is however advantageous if only the slot width is adjustable, in other words if no vacuum application that is sectioned in cross direction is available. In particular, distortable foil strips can also be utilized. They may have either a soft deformation-permitting material or may be sectioned across the width. An intervention is possible in this instance by adjusting the effective foil angle, whereby typical values are in a range of 0° to approximately 4°.

Alternatively, or in addition, the zones that are located successively in cross direction can partially overlap. Among other attributes, a soft profile is achieved. Formation of stripes is avoided. In this instance too, any combination of the previously discussed steps is possible.

The installation location of the elements that are cross profiled and arranged in zones, is especially in the area between the headbox and the water line. The stock consistency range of 0.1% to 7% can roughly be considered as the operative range. The stock consistency prevailing at the waterline depends on the product, or more precisely on the utilized fiber raw material (fiber length).

In sack paper produced from long fiber raw material with a low content of refined long fiber pulp, the stock consistency is in a range of approximately 0.1% to approximately 5%, preferably in a range of approximately 0.2% to approximately 3.5%. In products that are based on secondary fiber material the stock consistency is in a range of approximately 0.3% to approximately 7%, and preferably in a range of approximately 0.5% to approximately 5%. The same values are to be found in wood pulp that is ligneous primary fiber material having a respective fiber length of between long fibers and secondary fiber material. This also includes, for example GW (ground wood), PGW (pressurized ground wood), TMP, CTMP and RMP (refined mechanical pulp).

The respective foil angle can specifically be in a range of 0° to approximately 5° and preferably in a range of 0° to approximately 3°. The dewatering box can also be equipped with at least one perforated cover or at least one perforated plate. In accordance with a functional embodiment of the present inventive method a forming board, a dewatering box with at least one slotted or perforated cover or plate, and specifically several foil boxes can be used, over which the wire is carried.

The fibrous suspension can be treated specifically with vacuum in a range of 0 kPa to approximately 50 kPa, and preferably in a range of 0 kPa to approximately 25 kPa The relating elements can be utilized, especially in the following areas:

- In the forming process of the fibers, that is in an area in which the fibers are still mobile and the point of immobility has not yet been reached. This applies generally to the range of the medium stock consistency of 0.1% to approximately 7%, preferably 0.5% to approximately 5%.
- Particularly in stocks containing recovered paper (for example liner, carton, graphic papers), having a medium stock consistency $\bar{c}$ of: $0.3\% \leq \bar{c} \leq 7\%$ ($\hat{=} 3$ g/l $\leq \bar{c} \leq 70$ g/l); and
- With sack Kraft papers: $0.1\% \leq \bar{c} \leq 4\%$.

The present invention is applicable, particularly for a Foudrinier former, a twin wire former, especially a gap-former or hybrid former, or a graphic former. By definition, a graphic former may be a former for graphic papers, wrapping papers, cardboard, tissue or specialty papers. In addition, the present invention provides an advantage in a machine that is equipped with several sheet forming units for the production of multi-layer products, especially for the reduction of curling tendency. Here, the control or regulator system may, for example affect only one ply. In certain applications however, it is advantageous if the control or regulator system is effective upon at least two plies. Yet, at the same time the control or regulator system can, for example, be effective upon all plies.

The present invention can be utilized advantageously to influence at least one of the following properties of the fiber material web:

- Forming
- Tear length ratio R_L/R_Q

The aforementioned Tear ratio is especially significant with sack papers and format-type papers like wood-free copying paper.

The second more general aspect is met according to the present invention by a device for the production of a fiber material web, particularly a paper, cardboard or tissue web from a fibrous suspension. The device includes a forming zone and elements by which at least zonal pressure gradients are produced in the fibrous suspension during dewatering in the forming zone, in order to appropriately influence the principal fiber orientation.

In addition to the RL (Tear length) and formation the current invention can also influence the TSI behavior (TSI = tensile stiffness index) as desired. When using a diagonally slotted plate cover, designed according to the present invention, a reduction of the longitudinal/cross ratio of i.e. 0.3 to 0.5 was achieved. As already mentioned, the present invention is also applicable especially twin wire formers.

An appropriate diagonally slotted plate can, for example, also be utilized in a gap-former (i.e. DuoBase) or in a graphics former; for example also equipped with diagonal opposing blades or strips.

With small wrap angles, especially in a range of approximately 10 to approximately 30°, a positive effect of a longitudinal/cross reduction occurs. Due to the deflection losses occurring in the slots and at equal static pressure (air or wire tension pressure) the jet speed upon the wire is reduced. With a diagonal placement of strips the braking effect causes a decrease of the speed of the suspension on the wire, viewed in direction of machine travel, and that of neighboring jets at somewhat different times. This can lead to a transverse shear effect (longitudinal/transverse decrease).

Any combination of controlled and/or regulated dewatering, forming and/or wire guiding elements is possible, either interrelated or with other known dewatering, forming and/or wire

guiding elements that are not transversely structured. Below is a listing of possible examples that would be feasible:

- same-type elements follow in direction of machine travel
    - not laterally offset
    - laterally offset staggered
    - laterally offset alternating
- transversely structured elements, combined with non-transversely structured elements.

It is understood that the previously referred to characteristics of the present invention, as well as those yet to be explained below can be utilized not only in the cited combinations, but also in other combinations, or on their own without leaving the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a top view of an embodiment of the present invention;

Fig. 2a is a top view of two wire guides or dewatering elements in the form of strips according to an embodiment of the present invention;

Fig. 2b is an end view of a wire guiding or dewatering element in the form of a strip according to an embodiment of the present invention;

Figs. 3a-3d are top views of embodiments of wire guiding and dewatering elements of the present invention;

Figs. 4a-4c are end views of embodiments of two wires, viewed in the direction of wire travel 5, of a gap-former (not illustrated) according to the present invention;

Fig. 5 is a top view of an embodiment of a wire guiding or dewatering element according to the present invention;

Fig. 6 is a top view of an embodiment of a spreader type section unit with a herringbone pattern and carrying a wire according to the present invention;

Fig. 7 is a perspective view of an embodiment of a curved spreader according to the present invention;

Fig. 8 is a schematic partial view of an embodiment of a forming zone, including a Foudrinier former; particularly a Foudrinier former in a device for the production of a fiber material web, whereby the device is equipped with elements for the generation of at least one zonal pressure gradient according to the present invention;

Fig. 9 is a schematic top view of an embodiment of a plate equipped with diagonal slots for the generation of a pressure gradient according to the present invention;

Figs. 10-17 are various diagrams, reproducing test results achieved with or without vacuum, with a diagonally slotted plate suction box that are representative of paper quality parameters resulting directly from the present invention;

Fig. 18 is a schematic top view of an embodiment of a first installation example of an arrangement of foil strips that are arranged diagonally relative to the direction of machine travel according to the present invention;

Fig. 19 is a schematic top view of an embodiment of a second installation example of an arrangement of foil strips that are arranged diagonally relative to the direction of machine travel according to the present invention;

Fig. 20 is a schematic top view of an embodiment of a segment of a toothed bar arrangement, showing a stationary toothed bar and a toothed bar, that is sectioned in transverse direction according to the present invention;

Fig. 21 is a schematic top view of an embodiment of a segment of an arrangement including several diagonally slotted covers, located successively in direction of wire travel according to the present invention; and

Fig. 22 is a schematic illustration of an embodiment of a paper machine, including elements for cross-profiling in the wire section according to the present invention.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate one preferred embodiment of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more particularly to Fig. 1, there is shown sections of a top view of device 1 intended for the improvement of the properties of fiber material web 2.1, especially a paper, cardboard or tissue web produced from fibrous suspension 2 in a sheet forming device (not illustrated). Fiber material web 2.1 that is formed from fibrous suspension 2 is carried over a multitude of wire guiding and dewatering elements 4, when viewed in direction of wire travel S (arrow) by way of wire 3.1. Fig. 1 illustrates only one wire guiding or dewatering element 4.

The present invention provides that wire guiding or dewatering elements 4 are structured and/or directed transversely to the direction of wire 3.1 travel S (arrow) in order to thereby produce cross flows Q (arrow) relative to direction S of wire 3.1 travel, with the purpose of achieving better web properties and higher transverse strengths. The structuring 5 in wire guiding or dewatering element 4 shown in Fig. 1 is in the form of indentations 7.1, whereby wire guiding or dewatering element 4 is in the embodiment of plate 6, especially a support plate.

Fig. 2a shows top views of two wire guiding or dewatering elements 4 in the form of strips 4.1, especially support bars according to the present invention that are positioned parallel to each other whose structuring 5 is in the form of elevations 7.2. Elevations 7.2 can be in the embodiment of nubs and/or crowned and/or dome shaped and/or oblong structures. Fig. 2b, viewed in direction of wire travel S (dimensional arrow), shows wire guiding or dewatering element 4 in the form of strip 4.1 with nub type 8 structures 5 . The at least one wire is not illustrated in either of Figs. 2a and 2b.

Figs. 3a and 3d further show top views of wire guiding and dewatering elements 4 according to the present invention, all of which are designed as inclined curved short foils 4.2, or straight short foils 4.3. The at least one wire is not illustrated. As depicted in Figs. 3a and 3b, short foils 4.2 and short strips 4.3 are positioned in several rows diagonally to the direction of wire travel S (arrow) and parallel to each other. In Fig. 3c short strips 4.3 are positioned in a herringbone pattern (2 rows), transversely to the direction of wire travel S (arrow), together with overlap Ü, offset V and separation T at angles α_1, α_2. In contrast, short strips 4.3 in Fig. 3d are arranged at an angle α toward each other, including overlap Ü, viewed in direction of wire travel S (arrow).

The structured and/or directed wire guiding or dewatering elements 4 depicted in Figs. 1-3d can be installed in a sheet forming device in the embodiment of a hybrid-former, whereby they can be located only on the Foudrinier side or only on the hybrid-former side, or on both sides. A hybrid-former of this type is already known, for example from the applicant's German prior art document DE 197 06 940 A1 (PB10504 DE); the disclosure of this prior art document is herewith declared to be part of this description and the hybrid-former will, therefore, not be discussed in further detail. The depicted wire guiding or dewatering elements 4 can also be

installed in a sheet forming device in the form of a gap-former. In this instance they can be located on only one wire side, or on both wire sides.

Figs. 4a-4c each show two wires 3.1, 3.2, viewed in direction of wire travel S (dimensional arrow), of a gap-former (not illustrated), whereby the fibrous suspension is run between the two wires 3.1 and 3.2. A gap-former of this type (Twin Wire Former) is known, for example from the applicant's German prior art document E 40 05 420 A1 (PB04713); the disclosure of this prior art document is herewith declared to be part of this description and the gap-former will, therefore, not be discussed in further detail. Fig. 4a shows wire 3.1 being carried over a rotating element 9 that is in the embodiment of roll 10, shown as a sectional view. The surface of roll 10 can be grooved or spirally grooved. In contrast, wire 3.2 is carried by way of plate 6 or strip 4.1 that are structured 5 with nubs 8. Rotating element 9 and wire 3.1 can rotate or move at the same, or at different speeds (synchronism, forward motion, after-running) in the same, or in opposite direction. Rotating element 9 can also rotate at crawling speed, possibly even with an installed cleaning unit that however, is not illustrated.

In Figs. 4b and 4c both wires 3.1, 3.2 are each carried over plate 6 or strip 4.1, that are provided with nub-type 8 structuring 5. In both Figs. 4b and 4c it can be clearly seen that the nubs, viewed in direction of wire travel, are positioned to be not laterally offset (Fig. 4b) or to be laterally offset and staggered (Fig. 4c) or laterally offset and alternating (Fig 4c). It is understood that elevations 7.2 that are in the form of nubs 8 can also be developed as indentations and/or crowned and/or dome shaped and/or oblong structures. Nubs 8, as well as also the other possible elevations and indentations represent wire guiding or dewatering element 4 according to the present invention.

Fig. 5 shows a top view of wire guiding or dewatering element 4 according to the present invention, whereby short strips 4.3 are located in a row, crossing diagonally over at an angle α

and whereby the wire is not illustrated. In addition, the wire guiding or dewatering element according to the present invention can also be positioned alternating or in a pattern with a non-structured and/or non-directed wire guiding or dewatering element. The wire guiding or dewatering element according to the present invention can also be supported flexibly and/or rigidly, whereby in the second instance its position is adjustable relative to the wire, for example through sliding or pivoting. The wire guiding or dewatering element according to the present invention can, moreover, be supplied with vacuum and whereby the vacuum supply, with regard to cost-effectiveness, can occur by way of at least one preferred regulated/controlled vacuum box. Since the various elements of these additional design variations are already known from the state of the art, or are easily deductive, further explanations are dispensed with.

Figs. 6 and 7 show two additional structured and/or directed wire guiding or dewatering elements 4, according to the inventive device 1. Fig. 6 is a top view of a spreader type suction unit 11 with a herringbone pattern, carrying wire 3.1. In contrast, Fig. 7 is a perspective view of a curved spreader bar 12 in simplified form. A spreader roll is not illustrated, since it is known in the state of the art and has numerous uses in many applications. All structured and/or directed wire guiding or dewatering elements have in common that they can be utilized individually and/or in multiples and/or in combination of various types.

In summary, under the first aspect of the present invention, a method and a device are created to improve the properties of a fiber material web, particularly a paper, cardboard or tissue web produced from a fibrous suspension in a sheet forming device, whereby the properties that require a strengthened fiber orientation transversely to the direction of wire travel are improved without essentially detrimentally affecting those properties that profit from stronger relative movement between the fibrous suspension and the at east one wire of the sheet forming device.

In accordance with the second aspect of the present invention a method, as well as a device for the production of a fiber material web, specifically a paper, cardboard or tissue web from a fibrous suspension are generally cited, whereby during dewatering in the forming zone at least zonal pressure gradients are produced in the fibrous suspension, in order to influence the main fiber direction in the fiber material web accordingly.

Fig. 8 shows a schematic partial view of forming zone 14, in this instance a Foudrinier-Former in an example of a device for the production of a fiber material web that is equipped with elements for the generation of at least one zonal pressure gradient. Wire 16 can be seen that is carried over forming board 18, dewatering box 20 that is equipped with two, relative to the machine or web direction, diagonally slotted plate covers, or plates 22, 24 and several foil boxes 26. As can be seen in Fig. 8, the dewatering box is equipped with discharge 28. The dewatering box can be equipped with suction, whereby the fibrous suspension can, for example be treated with vacuum in a range of 0 kPa to approximately 50 kPa, and preferably in a range of 0 kPa to approximately 25 kPa.

Fig. 9 illustrates a schematic top view of an example design of a diagonally slotted plate 30 that serves to generate pressure gradients and whose slots 32 in this instance are inclined 45° opposite the direction of machine travel L. As an option, the surface of the diagonally slotted plate 30 facing the wire can be curved. The curvature radius of the surface can, for example be larger than 2 m, particularly larger than 5 m and preferably larger than 10 m.

Figs. 10-17 illustrate various diagrams that reproduce test results that were achieved with and without vacuum on a diagonally slotted plate suction unit and that are representative of paper quality parameters resulting directly from Figures 10-17.

Fig. 18 is a schematic top view of a first installation variation of an example arrangement (SSPS) of foil strips or diagonal slots that are positioned diagonally relative to the direction of

machine travel. As can be seen in Fig. 18, two groups of foil strips 34 and 36 are provided. In the present example, foil strips 34 of the one group are aligned differently than foil strips 36 of the other group. Foil strips 34 or 36 have a run-off pitch in the range of 0° to 5°.

Fig. 19 is a schematic top view of a second installation variation of an example arrangement of foil strips or diagonal slots 36 that are located diagonally relative to the direction of machine travel. In this instance too, two groups of foil strips 36 are again provided. In this instance however, foil strips 36 of these two groups are aligned same-directionally.

Fig. 20 is a schematic partial top view of a toothed bar arrangement 38, showing a stationary continuous toothed bar and toothed bar 42 that is sectioned in cross direction. As can be seen from Fig. 20, toothed bar arrangement 38 extends transversely to the direction of wire travel L. Various sections 1-4 are defined by the various adjustable sectional toothed bar segments 44 of sectioned toothed bar 42. Actuator 46 is allocated to each of the respective toothed bar segments 44 through which the relating toothed bar segment 44 is adjustable as desired. At the same time, the stationary continuous toothed bar 40, and the various toothed bar segments 44 collaborate in the illustrated manner, whereby in the toothed bar segments 44 in the present example are adjustable in direction of wire travel L.

Fig. 21 is a schematic top view of a section of an arrangement consisting of several diagonally slotted covers 48, 50 and 52 that are located successively in direction of wire travel L. As can be seen from Fig. 21, covers 48, 50 and 52 always extend transversely to the direction of wire travel L. Slots 54 are always placed diagonally relative to the direction of wire travel L. As can also be seen from Fig. 21, slots 54 in the respective covers 48, 50 and 52 can be positioned parallel to each other, at least in sections, or differently. In addition slots 54 can have the same length as each other, at least in sections, or they can be of different lengths. Orientation and

length of slots 54 in a cover can differ from slots 54 in another cover, a fact that is however, not imperative. Furthermore they can be provided particularly as previously described in detail.

Slot width b can, for example, be in a range of approximately 10 mm to approximately 100 mm, that is to say a slot width in direction of travel can be in the range of 14 mm to 140 mm, preferably of 25 mm to 100 mm. As can be seen in Fig. 21 a zone separation that runs parallel to diagonal slots 54 can, for example, be provided at the respective locations 56.

Fig. 22 is a schematic illustration of a purely exemplary layout of a paper machine whereby elements for cross profiling are provided in wire section 58. In the present example fibrous suspension 62 that is delivered from headbox 60 is brought onto wire 64 that, in wire section 58 is routed over forming board 66, suction box 68 together with the relating elements for controlling the cross profile, for example, at least one foil box 70, at least one suction box 72 and one suction couch roll 74. Following this wire section, the fiber material web, or paper web runs through press section 76, dryer section 78 and smoothing device 80 in order to be subsequently delivered to roller 82. Scanners 84 that are connected with control unit 86 are provided in the area of suction couch roll 74, press section 76, dryer section 78, smoothing device 80 and for example, also roller 82. A valve arrangement 88 through which various sections of suction box 60 can be treated with vacuum via vacuum generator 90 is triggered by control unit 86. Accordingly, controlling the cross profile is possible, as already previously described.

While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains

and which fall within the limits of the appended claims.